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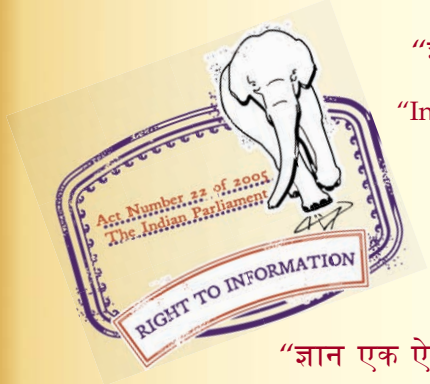


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"Knowledge is such a treasure which cannot be stolen"

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# *Indian Standard*

# METHODS OF SAMPLING STEEL FORGINGS

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# *Indian Standard*

# METHODS OF SAMPLING STEEL FORGINGS

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# *Indian Standard*

# METHODS OF SAMPLING STEEL FORGINGS

## 0. FOREWORD

**0.1** This Indian Standard was adopted by the Indian Standards Institution on 26 March 1979, after the draft finalized by the Methods of Sampling Sectional Committee had been approved by the Structural and Metals Division Council.

**0.2** The steel forgings industry in India has made considerable progress in the last few years, in unison with other manufacturing industries like automobile, aircraft, machine tools and other metal processing industries. The versatility of the forging process as also its likely phenomenal development in the coming years may lead to rapid growth of steel forgings. Standardization of the sampling procedure of steel forgings increases reliability of test results and avoids ambiguity, if any, between the supplier and the user.

**0.3** Proper quality control during the process of manufacture would substantially reduce quality fluctuations of the ultimate products. For effective process control, the use of statistical quality control techniques is imperative for which helpful guidance may be obtained from IS : 397 ( Part I )-1972* and IS : 397( Part II )-1975†. The sampling procedures recommended in the standard include certain broad outlines for process control.

**0.4** In reporting the result of a test or analysis, if the final value, observed or calculated, is to be rounded off, it shall be done in accordance with IS : 2-1960‡.

## 1. SCOPE

**1.1** This standard prescribes the methods of sampling and criteria for conformity for steel forgings. The broad outlines with regard to the controls to be exercised during the manufacturing process have also been indicated.

*Methods for statistical quality control during production: Part I Control charts for variables (*first rsvision*).

†Methods for statistical quality control during production: Part II Control charts for attributes and count of defects (*first revision*).

‡Rules for rounding off numerical values (*revised*).

## 2. TERMINOLOGY

**2.0** For the purpose of this standard, the following definitions shall apply.

**2.1 Item** — A unit, such as forging, meant for inspection or testing.

**2.2 Lot** — The total number of items of the same type and size under consideration originating from the same cast and having been produced under similar conditions of manufacture.

**2.3 Lot Size** — Number of forgings in the lot.

**2.4 Sample** — Number of items selected for inspection or testing from a lot.

**2.5 Sample Size** — Number of items in the sample.

**2.6 Defect** — Failure to meet the requirement imposed on an item with respect to any single characteristic.

**2.7 Defective** — A forging having one or more defects.

**2.8 Acceptance Number** — The maximum permissible number of defectives in the sample ( s ) for acceptance of the lot.

**2.9 Rejection Number ( r )** — The minimum number of defectives in the sample for rejection of the lot.

**2.10 Acceptable Quality Level ( AQL )** — The maximum percent defective that, for the purpose of sampling of steel forgings, can be considered satisfactory as a process average.

NOTE — When a purchaser designates some specific value of AQL, he indicates to the supplier that his ( purchaser's ) acceptable sampling plan will accept the great majority of the lots that the supplier submits, provided that the process average level of percent defective in these lots is not greater than the designated value of AQL. Thus, AQL is a designated value of percent defective that the purchaser indicates will be accepted most of the times ( approximately 89 to 99 percent ).

## 3. PROCESS CONTROL

**3.1** The object of inspection and testing steel forgings by the purchaser is to ensure their conformity to the specification requirements, whereas the inspection done by the manufacturer during production is to ensure conformity to relevant specifications as also to maintain better control over the process. Quality control during production can build quality and

reliability in the forgings whereas inspection done later on can only sort out the good products from the bad ones. Because of the economy that would result from the former approach, it is recommended that the manufacturer should take representative sample of the material at regular intervals to control the quality fluctuations during production.

**3.2** The recommended stages of manufacture and frequency of testing for process control are given below:

| *Characteristics* | *Stages of Manufacture* | *Frequency of Testing* |
|---|---|---|
| Chemical analysis | Raw material | One from each cast |
| | Final inspection | One from each lot |
| Dimensional check | Die sinking copy model | Each model |
| | Die sinking | Each forging |
| | Die finishing | do |
| | Lead cast inspection | do |
| | Forging ( hot ) inspection | do |
| | Primary inspection | do |
| | Heat treatment | do |
| | Final inspection | do |
| Forgeability, surface defects and internal defects | Raw material | One test from each lot |
| Mechanical properties | Raw material | One from each cast |
| | Heat treatment | Each heat treatment batch |

## 4. LOT INSPECTION

**4.1** In case adequate and satisfactory system of quality control has been maintained, the resulting data and information may be made available to the purchaser along with items supplied to enable him to judge the acceptability of the lot. When it is not possible to make such information available to the purchaser or if the purchaser so desires, the procedure laid down in the following clauses shall be followed for determining the conformity of the steel forgings to the requirements of the relevant specifications.

**4.2** The sample shall be selected and examined for each lot separately for ascertaining their conformity to the requirements of the relevant specifications.

### 4.3 Scale of Sampling

**4.3.1** *Visual, Mass and Dimensional Characteristics* — All the large and special forgings shall be inspected individually for visual, mass and dimensional characteristics which are important. Only those forgings which are found to be satisfactory with regard to all those characteristics shall be accepted.

**4.3.2** In the case of general forgings, the number of items to be selected from each lot shall be in accordance with Col 1 and 2 of Table 1.

**4.3.2.1** The items shall be selected at random from the lot. For selecting the items at random the provisions contained in IS : 4905-1968* shall be used.

**TABLE 1 SCALE OF SAMPLING AND PERMISSIBLE NUMBER OF DEFECTIVES FOR VISUAL, MASS AND DIMENSIONAL CHARACTERISTICS**

( *Clauses* 4.3.2, 4.3.3 *and* 4.3.4 )

| Number of Items in the Lot | For Visual Characteristics | | For Mass and Dimensional Characteristics | |
|---|---|---|---|---|
| | Number of Items to be Selected | Acceptance No. | Number of Items to be Selected | Acceptance No. |
| (1) | (2) | (3) | (4) | (5) |
| Up to 15 | 5 | 0 | 3 | 0 |
| 16 „ 25 | 8 | 0 | 5 | 0 |
| 26 „ 50 | 13 | 1 | 8 | 0 |
| 51 „ 100 | 20 | 1 | 13 | 0 |
| 101 „ 150 | 32 | 2 | 20 | 1 |
| 151 „ 300 | 50 | 3 | 32 | 1 |
| 301 „ 500 | 80 | 5 | 50 | 2 |
| 501 „ 1 000 | 125 | 7 | 80 | 3 |
| 1 001 „ 3 000 | 200 | 10 | 125 | 5 |
| 3 001 „ 10 000 | 315 | 14 | 200 | 7 |
| 10 001 and above | 500 | 21 | 315 | 10 |

NOTE — The associated AQL's (*see* **2.10**) for visual characteristics and mass/dimensional characteristics are 2·5 and 1·5 percent respectively. These AQL values will strictly hold good only in the case of larger lots.

*Methods for random sampling.

**4.3.3** Each item selected according to Col 1 and 2 of Table 1 shall be inspected for visual characteristics. Any item failing to meet one or more of the requirements shall be considered as defective. If the number of defectives found in the sample is less than or equal to the corresponding acceptance number given in Col 3 of Table 1 the lot shall be considered as conforming to the requirements of visual characteristics.

NOTE — In case of those lots which have been found unsatisfactory, all the items in the lot may be inspected for visual characteristics and the defectives may be removed, if agreed to between the purchaser and the supplier.

**4.3.4** The lot which has been found satisfactory with respect to visual characteristics shall be further inspected for mass and dimensional requirements. The number of items required for this purpose shall be taken at random in accordance with Col 1 and 4 of Table 1. These may be taken from those items which have been found conforming to visual characteristics. If the number of defectives found in the sample for mass and dimensional requirements is less than or equal to corresponding acceptance number ( *see* Col 5 ), the lot shall be considered as conforming to the requirements of the relevant specifications, otherwise not.

### 4.4 Surface and Internal Defects

**4.4.1** Unless otherwise agreed to between the supplier and the purchaser, the items taken for testing visual characteristics may be used to assess the surface and internal defects.

**4.4.2** The requirements relating the state of surface may be specified and agreed to while ordering.

**4.4.3** The use of special techniques either during inspection or after delivery for the detection of the surface defects as well as the methods of interpreting the results must be agreed while ordering.

**4.4.4** The use of special techniques for inspection, such as radiography, ultrasonics, magnetic detection and grain flow for the detection of internal defects as well as methods of interpreting the results shall be agreed while ordering.

## 5. CHEMICAL CHARACTERISTICS

**5.1** The lot which has been found satisfactory with respect to visual, mass and dimensional requirements shall be tested for chemical analysis. The number of items required for this purpose shall be taken at random in accordance with Col 1 and 2 of Table 2. These may be taken from those items which have been found conforming to mass and dimensional characteristics.

TABLE 2 SCALE OF SAMPLING FOR CHEMICAL ANALYSIS

( *Clauses* 5.1 *and* 6.4 )

| Number of Items in a Lot | Number of Items to be Selected |
|---|---|
| (1) | (2) |
| Up to 50 | 2 |
| 51 „ 150 | 3 |
| 151 „ 500 | 5 |
| 501 and above | 8 |

NOTE — If there is only one item in a lot, that item shall be tested for chemical analysis.

**5.1.1** For each of the items, drilling shall be taken and a composite sample shall be made. The lot shall be considered as complying with the requirements of various chemical constituents, if the analysis made on the composite sample conforms to the requirements of the relevant specifications.

## 6. MECHANICAL PROPERTIES

**6.1** The lot which has been found satisfactory for visual, mass and dimensional characteristics and chemical analysis shall next be tested for physical properties like tensile strength, bend test, fracture test, impact test, hardness test and mechanical tests at a fixed temperature, and long duration tests.

**6.2** The specimen shall be selected in such a manner that it represents the material and shall be so prepared that it conforms to the relevant specification to ensure uniformity of test procedure.

**6.3** While conducting the test, uniform conditions shall be imposed, such as rate of loading, concentric application of the load, testing machines of like sensitivity and accuracy and specimens of the same dimensions and form.

**6.4** The number of items required for this purpose shall be in accordance with Col 1 and 2 of Table 2. These items may be those from which drilling has been taken for chemical analysis.

**6.5** From each of the items so selected, the required number of test specimens shall be prepared for conducting the physical tests specified.

**6.6** For each characteristic, from the test results obtained, the average ( $\bar{x}$ ) and the range ( R ) be calculated as below:

$$\text{Average } (\bar{x}) = \frac{\text{Sum of the test results}}{\text{Number of test results}}$$

$$\text{Range } (R) = \text{Difference between the maximum and minimum values of the test results}$$

**6.7** If the specification limit for the characteristic is given as a minimum value, the expression ( $\bar{x} - kR$ ) shall be calculated from the relevant test results. If the value obtained is greater than or equal to the minimum specification limit, the lot shall be considered as conforming to the requirements of that characteristic.

**6.8** If the specification limit for the characteristic is given as a maximum value, the expression ( $\bar{x} + kR$ ) shall be calculated from the relevant test results. If the value obtained is less than or equal to the maximum limit, the lot shall be declared as conforming to the requirements of that characteristic.

**6.9** If the characteristic has two-sided specification limits, the expressions ( $\bar{x} - kR$ ) and ( $\bar{x} + kR$ ) shall be calculated from the relevant test results. If the values obtained lie between the two specification limits, the lot shall be declared as conforming to the requirements of that characteristic.

**6.10** The value of the factor $k$ refferred to earlier shall be chosen in accordance with Table 3 depending upon the desired acceptable quality level.

**TABLE 3 VALUES OF $k$ FOR ACHIEVING DIFFERENT ACCEPTABLE QUALITY LEVELS**

| ACCEPTABLE QUALITY LEVEL, PERCENT | VALUE OF $k$ |
|---|---|
| 2·5 and up to 4·0 | 0·4 |
| 1·0 and up to 2·5 | 0·5 |
| Less than 1·0 | 0·6 |

**6.11** If the characteristics are of attribute type like bend test and fracture test, the lot shall be considered as conforming to the requirements if each of the test results is found to be satisfactory.

**INDIAN STANDARDS**

**ON**

**METHODS OF SAMPLING OF ORES AND RAW MATERIALS**

IS:

1405-1966 Methods of sampling iron ores (*first revision*)
1449-1976 Methods of sampling manganese ore (*first revision*)
1472-1977 Methods for sampling ferro-alloys for determination of chemical composition (*first revision*)
1811-1961 Methods of sampling foundry sands
1817-1961 Methods of sampling non-ferrous metals for chemical analysis
1999-1962 Methods of sampling bauxite
2109-1962 Methods of sampling dolomite, limestone and other allied materials
2245-1962 Methods of sampling quartzite
2246-1963 Methods of sampling fluorspar (fluorite)
3191-1968 Methods of sampling cryolite and aluminium trifluoride
3704-1966 Methods for sampling of light metals and their alloy products
4156-1967 Methods for sampling of baryies
4166-1967 Methods for sampling of ilmenite and rutile
4711-1974 Methods for sampling of steel pipes, tubes and fittings (*first revision*)
6492-1972 Methods for sampling of powders for powder metallurgical purposes
6907-1973 Methods of sampling steel castings
8562-1977 Methods of sampling chrome ore